

THERMOFORMED PLATFORM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of United States Patent Application No. 09/803,681 filed on March 12, 2001, which claims the benefit of U.S. Provisional Application No. 60/196,127, filed on April 11, 2000. The disclosures of the above applications are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates to industrial platforms and in particular to plastic pallets with improved features and characteristics preferably constructed according to triple sheet thermoforming methods.

BACKGROUND OF THE INVENTION

[0003] Wooden stringer pallets are the preferred materials of pallet construction within the North American distribution system. Four hundred (400) million new or refurbished wooden pallets are introduced into a distribution system comprising 1.9 billion pallets each year, according to the US Forest Service.

[0004] Plastic pallets have been used to replace wood pallets with some degree of success over the past several years. Plastic pallets have a low market share however because they suffer from one significant disadvantage in that they are considerably more expensive than a comparable wooden pallet.

Thermoplastic materials constitute a significant proportion of the total cost of a plastic pallet, and a given amount of relatively expensive plastic material is required to produce a pallet with a measure of load-bearing strength that is comparable to wooden pallets. Therefore, the plastics industry is attempting to overcome the initial price difference that exists between wooden and plastic pallets, so that the plastics industries can gain more market share.

[0005] Approximately 4 to 6 percent of the annual North American production of pallets are in the form of plastic pallets. Increasing the strength while utilizing less material is an important object of the plastics industry. The plastic industry however has reached a plateau. Only marginal, rather than significant break through in increased strength to weight ratios have been anticipated using conventional methods of the plastics industry.

[0006] The twin sheet thermoforming sector of the plastics industry has captured a share of the plastic pallet market disproportionate to its share of the overall plastics industry. Accordingly, it may be suggested that the art of thermoforming is a competitively and comparatively advantageous starting point for the development of new break through plastic pallet methodologies.

[0007] The "standard" 48 x 40-inch wooden stringer pallet has a dynamic load bearing performance specification of 2,800 pounds. This load bearing specification is the benchmark against which plastic pallets are compared. In order to meet this specification in thermoformed plastic, a combination of two (x2) twin sheet pallet members have been proposed. Two

twin sheet members are combined to provide what is known in the material handling industry as a rackable plastic pallet.

[0008] Conventional rackable twin sheet pallet designs comprise a load supporting platform and a load-distributing base. Three common techniques are used by thermoforming practitioners to join the load supporting platform and the load distributing base in a fixed spaced apart relationship for the introduction of fork lift tines and the like for movement and storage of the plastic pallet within the distribution system. A first method characterized in US Patent 5,413,052 to Breezer et al., utilizes a plurality of separately molded blocks to maintain the twin sheet members forming the deck and the base of the pallet a fixed distance apart. A second method characterized in US Patent 5,117,762 to Shuert suggests a load supporting platform with a plurality of depending legs to maintain the twin sheet pallet members a fixed distance apart. In yet another method, two pallet members are fused together where corresponding mirror image projecting elements upon each member come together, as in US Patent 5,401,347 to Shuert. Each method characterized presents problems. In the first methodology, an undesirable plurality of mechanical fasteners and molded elements are required. In the second method, the load-bearing surface of the platform has pockets forming the leg projections, which reduces the surface area available for supporting a load. In the third method, where the two members are fused together, the arrangement is disadvantageously permanent. These approaches are not satisfactory. A low cost means of coupling and de-coupling the members of a racking style pallet is needed.

[0009] In order to meet the 2,800-pound load bearing benchmark it has also been necessary to encapsulate metal frame structures between the twin sheets comprising the thermoformed pallet members. US Patent 5,404,829 to Shuert illustrates in Fig. 7 how the top sheet of thermoplastic forming the load support deck includes elements that depend downward from the surface to capture reinforcing beams. In the US Patent 5,413,052 execution of a reinforced pallet no depending elements on the load-bearing surface are suggested. A substantially uninterrupted surface is preferred over a relatively stronger developed surface having several pockets or depressions. The deck member of '052 would however be unsatisfactory for supporting loads without the reinforcing cross members because this structure would be considerably weaker than a deck with a developed surface structure. Accordingly, a mold combination that can produce either a strong non-reinforced or an exceptionally strong reinforced pallet without interruptions on the load-supporting surface would be advantageous and is therefor needed.

[0010] Plastic pallets must also provide a level of fire resistance that is at least equal to or better than wooden pallets should a fire occur within the warehouse setting. Plastic pallets will not substitute wooden pallets on a large scale if plastic pallets create hazards that prevent a fire from being extinguished. A plastic pallet that creates more fire hazards than a wooden pallet will necessitate fire protection upgrades, including increased sprinkler systems and insurance premiums that could become very costly to the plastic pallet user. According to this problem, one pallet known as the GE Extreme™ Pallet has

been offered. The GE Extreme™ Pallet is UL classified and Factory Mutual approved to meet the National Fire Code (NFPA 13) for commodity and idle storage of pallets. Although this particular plastic pallet has been used to some advantage, it is nonetheless heavy weight (approx. 57.5 pounds) and is constructed of plastic materials made from expensive General Electric Company Noryl® and Xenoy® resins. The problem is that these resins are considerably more expensive than the commodity resins of the olefin group such as polyethylene and polypropylene, which are the preferred materials for constructing low cost plastic pallets.

[0011] A number of methodologies have been used in the past to provide fire retardant polyolefin compositions, as for example in electrical wiring. These prior art methods may be known by referring to United States Patents 3,810,862 to Mathis et al, 5,356,983 to Vijayendran et al. and 5,946,878 to Grund et al. A first problem with these methods is that the materials are relatively expensive as they are used throughout the article's resinous composition. A second problem is the resultant loss of the physical properties and general processability of the carrier resin forming the article.

[0012] Coatings have also been proposed to provide protective fire retardant properties to plastic structural articles, and may be understood by referring to United States Patents 5,924,589 to Gordon and 6,110,559 to De Keyser. An intumescent coating system comprising a first layer providing a breakthrough barrier and a second layer providing thermal insulation has also been proposed, as in 5,989,706 to McGinniss et al. Problems with coating

systems are that they require secondary manufacturing operations and materials which can be expensive to acquire and apply and they would be subject to damage / removal in a rough pallet handling environment.

[0013] It is known that thermoformable resins can be co-extruded to yield an engineered sheet construction with enhanced characteristics. For example, United States Patent 5,143,778 to Shuert proposes a co-ex sheet construction to provide a more rigid pallet structure. The co-ex principle has been suggested by Gordon in 5,984,126 to provide an industrial container formed from a structural sheet that has an outer layer of fire resistant intumescent material to prevent the breaching and subsequent spilling of flammable lading. Although the Gordon approach may be useful in some applications, it would be difficult to implement the approach in a twin sheet pallet that would typically be under load. Polyolefins have a notoriously low heat deflection temperature and a co-ex intumescent twin sheet pallet construction would surely collapse when softened by the heat of a fire. It is also not known what intumescent admixture Gordon proposes. Another problem being that an intumescent system must be processable by the practitioner of thermoforming methods. According to these problems, a new and useful approach is needed to provide a fire resistant pallet that will also maintain its load bearing strength in high temperature environments.

[0014] It may also be appreciated that conventional wooden pallets are low-tech. Plastic pallets are becoming increasingly sophisticated. A hollow pallet having an internal wireless communications device that triggers a 911

emergency data signal in response to a fire or the heat of a combustion flame to a remote “emergency” monitor would be beneficial.

[0015] It is also understood that plastic pallets have been used to replace wooden pallets with some success because wooden pallets deteriorate through normal wear and tear. Examples of wooden pallet deterioration include, but are not limited to, splintered wooden boards and stringers and projecting nails. In addition to causing damage to packaging materials and automated pallet handling equipment, these examples of deterioration also cause workforce injuries as a result of manual wooden pallet handling. While plastic pallets eliminate these problems to a large extent and have been used to some advantage because they do not deteriorate in the same fashion, it may be argued that plastic pallets remain nonetheless difficult to manually handle by warehouse workers because of their heavyweight construction. Pallets in the prior art have not been developed with ergonomic principles in mind. Ergonomic pallets are needed.

[0016] It is also known that plastic pallets, which are used to support loads that may be suspended upon racks adjacent the work area of a warehouse worker, are often times constructed of plastic materials that exhibit low coefficients of friction. Two such materials with relatively low coefficients of friction include polyethylene and polypropylene. According to this potential safety problem it has been advantageous to offer such pallet materials with skid resistant properties or treatment. For example, in United States Patent 4,428,306, a non-skid surface is applied to the polyethylene sheet prior to

forming the pallet structure. Alternatively, in United States Patent 5,648,031, it has been suggested anti-slip droplets may be sprayed upon the surface of the material forming the plastic pallet to provide a skid-resistant treatment. Although these and other approaches provide some skid resistant protection they are disadvantageous in that they required additional material and or processing expense in their original manufacture and eventual recycling. Pallets with a high coefficient of friction surface on the top and the bottom are needed to prevent slippage of the load carried by the pallet, and slippage of the pallet on the support surface.

[0017] It is also known that plastic pallets must interface within distribution networks where it is common to unitize a pallet load with shrink-wrap and other banding materials. Plastic pallets have not been adequately developed to interface with these and other packaging methods. In US Patent 5,676,064 to Shuert, a downward extending peripheral lip and indents in the outer leg structures are suggested to accommodate packaging materials. Similarly, in US Patent 5,408,937 to Knight, et al., indented surfaces upon the legs are suggested to receive wrapping materials. Although these arrangements are helpful, they do not allow the warehouse worker to manually and ergonomically initiate the starting stretch and cling of widely used packaging films around the pallet for final unitization. A pallet amenable to unitization is needed.

[0018] Regarding the foregoing, it is understood that plastic and in particular thermoformed plastic pallets have many advantages over wooden pallets. These advantages are properly recorded in the prior art. The

disadvantage of initial price, however is increasingly a more complex justification for selecting wooden pallets when these are compared to plastic pallets. Although twin sheet plastic pallets have been employed successfully to replace wood, breakthroughs in the cost equation and the value-added execution of thermoformed plastic pallets are finally needed to justify a wholesale conversion from wooden pallets to plastic pallets.

SUMMARY OF THE INVENTION

[0019] It is therefore an object of this invention to provide a comparably stronger industrial platform than has heretofore been possible using conventional thermoforming methods.

[0020] According to this object, pallet structures with higher load bearing strength are offered using a triple sheet thermoforming methodology. According to this methodology, triple sheet pallets using the same measure of plastic as in a twin sheet pallet are significantly stronger than twin sheet pallets. It is also an object of this invention to offer a triple sheet pallet, while using less material, which is equal in strength to a twin sheet pallet. According to this aspect, the plastic forming the triple sheet pallet is extruded in a thinner over-all gauge to reduce costs. The relatively thinner sheets of plastic are therefore specially developed for triple sheet thermoforming. Three molded sheets can provide the same load bearing strength as two molded sheets, even though the combined weight of the three sheets is significantly lower than the combined weight of the two sheets. According to this aspect triple sheet pallets, using a

much lower measure of plastic, provide the same load bearing strength as significantly heavier and therefore costlier twin sheet pallets.

[0021] Other objects of the present invention are offered below. The present executions of triple sheet thermoformed pallets embodied herein are not presented as being definitive but rather as exemplary of the improvements and advantages that are attendant when executing a plastic pallet in a thermoforming methodology. Many embodiments of the present triple sheet pallet may also be used in twin sheet pallets.

[0022] Another object is to provide heat deformable plastic with improved hot tack adhesion characteristics for increased bond strength. A thinner or lower over-all measure of plastic can be used successfully if the sheet construction is amenable to improved hot tack adhesion. A means of scuffing the surface of the sheet, as it is extruded prior to thermoforming, is disclosed. One or both surfaces of the sheet material suggested for use in a pallet can be scuffed selectively to increase sheet-to-sheet bond strength.

[0023] It is an objective to be able to selectively join and un-join the members forming a pallet in order to increase their efficiencies of use. It is therefore suggested that the sheets forming the pallet members include interfacing clasping features. A “snap together and snap apart” feature is provided. According this aspect, the feet of the load-supporting platform include protrusions that are received in recessions formed in the load-distributing base. Two pallet members are joined by a snap fit to provide a rackable pallet. A snap together, snap a-part improvement will allow the pool of pallet members to be

more effectively marshaled, and thus reduced in over-all number, according to asset management principles.

[0024] Another objective is to develop the three molds deforming the plastic sheet to accept rigidifying cross members without modification (such as the replacement of loose pieces or substitute molds). In this manner a non-reinforced pallet member may be replaced with a reinforced pallet member in response to demand fluctuation and changing customer requirements. When the non-reinforced pallet member is formed in the triple sheet manufacturing process, the details otherwise receiving the cross members mold over or web together providing structural strength when an insert is not offered. Accordingly one mold group may be employed to produce either a rigid non-reinforced pallet member or a substantially more rigid reinforced pallet member. When metal reinforcements are preferred, these may be placed advantageously between the first and the second, or the second and the third sheet formed in the triple sheet thermoforming sequence to yield a heavy-duty reinforced pallet structure.

[0025] Another object is to offer a plastic pallet that is as much as or less than a fire hazard as wooden pallets. According to this object, the sheet forming the thermoformed pallet is developed to provide a fire resistant barrier that is more fire resistant than wood. According to this aspect, an intumescent polymeric material is co-extruded over the polyolefin resins, such as polyethylene or polypropylene forming the core substrates of the top and bottom sheets comprising the thermoformed pallet. According to this aspect only a relatively small amount of comparably expensive intumescent polymeric material is used to

provide a fire resistant plastic pallet. The use of a smaller measure of expensive fire resistant material as a protective fire retardant surface is more economically advantageous than producing the entire pallet with such expensive fire resistant materials as has been provided for in the past by the aforementioned examples. In accordance with this objective, an intumescent system that has good thermoforming processability is also provided. In further accordance with this object, the intumescent system provided also has excellent thermal insulating properties, which properties are preferred so that the interior structural sheet of the triple sheet pallet is protected against the heat that is generated by the high temperature of the combustion flame. By preventing the interior structural sheet from softening upon exposure to heat the pallet will be able to maintain its load carrying properties even while the outer sheets exposed to flame decompose through intumescent efficiency. Accordingly, it is will be further understood why a triple sheet pallet with a central structural member is superior to a conventional twin sheet pallet in which only two exposed sheets are developed to provide load bearing strength. In further accordance with this objective, the cross members that may be inserted within the core of the pallet to provide additional load bearing strength may also be provided with intumescent properties to decrease their thermal conductivity within the pallet structure. These arrangements will help to protect fire fighters working adjacent pallet loads suspended in idle storage upon warehouse racks during a fire and should help reduce the damaging consequences of a fire by maintaining the stored articles upon the pallets.

[0026] Another object includes a wireless communications device within the plastic pallet that responds to a fire or the high heat of a fire by triggering an emergency 911 data transmission to a remote monitoring location. Such adaptations to the wireless communications device would be contemplated in connection with the principles and equipment disclosed by the present inventor's co-pending U.S. Patent Application entitled "Thermoformed Apparatus having a Communications Device," filed 01/24/00, which is incorporated hereunder in its entirety by such reference.

[0027] Another object is to provide handles adjacent the perimeter of the plastic pallet so warehouse workers can manually handle the plastic pallets with less chance of injury. According to this aspect, a pair of handles are provided along the margin of the pallet and the plastic pallet base is provided with a skid plate along its leading edge opposite the handles to increase the pallet's resistance to wear through abrasion cause by pallet dragging.

[0028] Another object is to provide a plastic pallet with surfaces having high coefficients of friction so that cargo carried by the pallet does not easily shift or dislodge to injure a warehouse worker. According to this object, the sheet surfaces comprising the pallet are scuffed during the extrusion process to provide a skid resistant surface that does not add material or processing cost and is 100 percent recyclable.

[0029] Still another objective is to provide a means for securing a variety of packaging materials to the members forming the plastic pallet. The four corner zones of the load carrying deck may be developed to receive a knot of

shrink-wrap material so that a dispensing roll may be manually employed satisfactorily by the warehouse worker. The opposing peripheral edges between the four corners of the pallet may include selectively located depending structures that are amenable to receiving stretch wrap, banding, straps and the like. A saw tooth or a serrated boarder configuration positioned between the leg pockets may be provided to engage a plurality of different packaging elements for their economical deployment by a warehouse worker.

[0030] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0032] FIG. 1 is a perspective view of a nestable pallet having nine leg pocket

[0033] FIG. 2 is a perspective view of a nine-legged pallet having an uninterrupted load-supporting surface.

[0034] FIG. 3 is a partial perspective view of the bottom first sheet common to both the pallet members embodied in FIGS. 1 and 2.

[0035] FIG. 4 is a partial perspective view of the middle second sheet of the pallet member embodied in FIG. 1.

[0036] FIG. 5 is a partial perspective view of the top third sheet of the pallet member embodied in FIG. 1.

[0037] FIG. 6 is a perspective view of a load distributor with four cutouts for receipt of the wheels of a pallet jack.

[0038] FIG. 7 is a partial perspective view of the top first sheet of the load distributor of FIG. 6 suggesting the location of reinforcing inserts for increased load bearing strength.

[0039] FIG. 8 is a partial perspective view of the middle second sheet of the load distributor of FIG. 6 suggesting how the structural molding details are developed to optionally receive reinforcing inserts.

[0040] FIG. 9 is a partial perspective view of the bottom third sheet of the load distributor of FIG. 6 having a scuffed underside surface for increased skid-resistance.

[0041] FIG. 10 is a perspective view showing the combination of the nine-legged pallet of FIG. 2 and the load distributor of FIG. 6.

[0042] FIG. 11 is a cross section view showing the combination of the intumescent composition sheet and the interior structural member of the fire retardant pallet.

[0043] FIG. 12 is a sectional view taken along the line A-A in the region of the center perimeter leg of the FIG. 10 embodiment showing the snap together feature of the present invention.

[0044] FIG. 13 is a sectional representation of an alternative embodiment of a snap together feature including an insert member, such as a segment of a wooden 2 x 4, for a reinforced pallet arrangement.

[0045] FIG. 14 is a sectional view of the apparatus forming the projection of the snap together feature associated with load distributor.

[0046] FIG. 15 is a sectional view of the apparatus forming the recess of the snap together feature associated with either the nesting or nine-legged pallet members of FIGS. 1 and 2.

[0047] FIG. 16 is a perspective sectional view of a portion of the load distributor suggesting how rigidifying inserts may be placed between the first and second sheets for increased load bearing strength.

[0048] FIG. 17 is a partial perspective view of a nesting pallet member showing a corner notch of the present invention arranged to receive a segment of shrink wrap film for unitizing a pallet load.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0049] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0050] United States Patent Application 09/377,792, in the name of the present inventor, discloses triple sheet thermoforming apparatus, methods and articles, and is incorporated herein, in its entirety, by such reference. It has been determined by the present inventor that three sheets of plastic can be

sequentially thermoformed in a single manufacturing process to provide a unitary article, such as a pallet, having a hybrid honeycomb type structure. The inventor has reduced triple sheet load bearing platforms to practice and has compared the same to several corresponding bench mark twin sheet load bearing platforms in a controlled test environment administered by an independent third party. Triple sheet platforms have a demonstrably superior level of load bearing strength than twin sheet platforms having substantially the equivalent weight or volume of plastic material. Accordingly, three relatively thinner sheets comprising a much lower volume of plastic can be utilized in a triple sheet method to provide a given requirement of load bearing strength offered by a twin sheet method. A triple sheet pallet construction is therefore preferred over a twin sheet pallet construction.

[0051] One purpose for thermoforming three sheets of plastic and sequentially fusing them together under progressive compressive forces is to provide a unitary structure that develops more strength than can be achieved in a twin sheet construction. Substantial interfacial adhesion throughout the body of a triple sheet structure is therefore desirable to provide a strong article. A comparably stronger triple sheet article can therefore be reduced in weight to provide the same measure of strength as a twin sheet article for economic advantage.

[0052] Two sheets of alike plastic material achieve interfacial adhesion when the alike plastic material reaches a hot tack or melting temperature and are compressed together. In the thermoforming methodology, compression may be

facilitated by either mechanical compression or by differential atmospheric pressure as in applied vacuum. It is known that thinner plastic sheets displace temperature faster than comparatively thicker sheet of equivalent plastic. Thus it is advantageous to increase the surface area of the thinner plastic sheet to provide enhanced hot tack adhesion characteristics. Scuffing the surface(s) of the relatively thin gauge of sheet to increase the molecular surface area and subsequent bond strength of the deformable plastic sheet is offered as an improvement over the prior art. The present improvement of scuffing sheet to improve the bond strength between the sheets of plastic make possible the use of relatively thinner sheet of plastic material and thus enables implementation of an object of the present invention.

[0053] In practicing the methods of triple sheet thermoforming, in which case it may be preferable to use a lower measure of plastic, relatively thinner sheets of plastic are therefore utilized to advantage. This preference exists in the case of plastic pallets because plastic pallets are more expensive than comparable wooden pallets. In a preferred method, three sheets of heat deformable plastic are sequentially molded and selectively fused together by means of hot tack adhesion and compressive forces. In triple sheet methods, the first sheet is formed upon a lower platen mold and the second and third sheets are successively formed on second and third molds on an upper platen. The effect of hot tack adhesion is not achieved when alike plastics fall below a given temperature threshold. When thinner sheets of heat deformable sheet are used, heat dissipation is accelerated, and satisfactory hot tack adhesion may not result

in the selected bonding locations, even under compression. According to this potential problem, the three sheets are developed to provide increased surface area to promote hot tack adhesion in selected areas where the sheets are required to fuse together. Increased surface area allows the practitioner of the triple sheet thermoforming method to utilize relatively thinner sheet of heat deformable plastic material.

[0054] It is customary to extrude thermoformable plastic through rollers imparting a substantially smooth surface in the twin sheet thermoforming art. Smooth surfaces have comparably low surface areas. (The exposed surfaces of twin sheet thermoformed articles are typically provided with texture by a textured tooling surface.) In the twin sheet art it is not always necessary to have surfaces with high energy. This may not be the case in the triple sheet art. In other market places, plastic scuffing is used advantageously for a variety of purposes. Two notable examples of scuffing, in which no other materials are introduced, are suggested in the prior art. A first example includes FrictionFlex® Textured HDPE sold by GSE Lining Technology of Houston, TX. In this application scuffing of the sheet is provided to enable steep tractor ascents over thermoplastic (industrial, garbage and pond) liners. The FrictionFlex® method may be comprehended by referring to United States Patent 5,728,424. In a second example, skid resistant bed liners for pick up trucks, which are constructed of low cost polyethylene, are also known to have a preferred high coefficient of friction to prevent the slippage of cargo contained thereon. As disclosed in United States Patent 6,095,787 heavy-duty brushes are counter rotated over the surface of the sheet during the

extrusion phase to provide a surface having a high area or surface energy. These low cost scuffing methodologies are incorporated by reference herein to provide a high area, high energy surface(s) amenable for practicing the art of triple sheet thermoforming with relatively thin sheets of plastic.

[0055] In the present example, three successive sheets of heat deformable material are delivered to the thermoforming apparatus. The top surfaces of the three plastic sheets in the present embodiment are scuffed in a manner suggested, particularly in accordance with the method of 6,095,787. Consequently, according to one of the possible sequences of the triple sheet methodology, the first sheet is molded into a female mold supported upon the lower platen. In this arrangement, the scuffed top surface of the first sheet molded is exposed for compression against the un-scuffed surface of the second sheet to be thermoformed. When the first sheet and the second sheet, which has been separately formed on a second mold associated with an upper platen, are brought together under compression by the relative movement of the platens the scuffed first sheet more effectively bonds to the corresponding un-scuffed surface of the second sheet.

[0056] When the second sheet is released from the clamp frames, and allowed to descend with the first sheet as a twin sheet sub-assembly into a lower platen extract position, a third mold associated with the upper platen deforms a third sheet. The lower un-scuffed surface of the third sheet is subsequently compressed against the scuffed surface of the second sheet by vertical movement of the lower platen in timed sequence. In this arrangement, the

second scuffed sheet surface is able to achieve a higher degree of hot tack adhesion with improved bond strength to the third sheet than would be the case if the second plastic sheet had a substantially smooth finish with comparably lower surface area and energy. Thus, it may be appreciated that if the second sheet temperature falls below the hot tack or melting temperature during the third sheet forming operation, the increased surface area of the second sheet will absorb heat from the third sheet when these are brought together. The absorbed heat will yield a higher strength bond when the two members are brought into contact under compressive force. Deformable scuffed sheet allows the practitioner to advantageously use thinner sheet to meet objectives of the present invention.

In the present thermoforming sequence, the top surface of the third plastic sheet is scuffed and therefore provided with a high coefficient of friction surface for a secondary skid resistant advantage. As in the present case, this is preferable, because the scuffed surface of the third sheet helps to support the load upon the pallet. As in the case of the pallet embodiments of FIGS 1 and 2, this sequence of sheet use produces a skid resistant pallet deck.

[0057] Another advantage of this method is that a single source of common sheet may be employed in the present application of triple sheet thermoforming for more than one advantage. It should also be noted that both surfaces of the sheet may be scuffed during the extrusion phase, or a plurality of sheet materials may be offered with predetermined scuffed and un-scuffed combinations, depending upon the preferences of the triple sheet practitioner. It should also be noted that the present arrangement for scuffing sheet might also

be applied advantageously to twin sheet applications where interfacial bond strength is inadequate for the article's intended purpose. It should also be noted that scuffing could be utilized in thermoforming operations that produce articles other than industrial platforms including pallets. Other such articles include, but are certainly not limited to the following: gas tanks for vehicles, boat hulls, industrial containers, dumpster lids, wall and door panels, exterior automotive and aerospace bodies, recreational and sporting goods, lawn and garden products, home appliances, and any other primary end market categories in which thermoformed articles are provided.

[0058] Accordingly, as illustrated to advantage in Figs 3, 4 and 5, which show a single quadrant of a four quadrant pallet member, the three sheets 2a, 2b and 2c forming a load supporting platform 4 are scuffed during the extrusion phase in accordance with US Patent 6,095,787 to provide a high surface area finish 6. The opposite sides of sheets 2 are provided with a substantially smooth surface 8, but may also be scuffed as preferred by the triple sheet practitioner. As may be appreciated by quickly referring to Figures 1 and 2, load-supporting platforms 4a and 4b are comprised of three sheets of heat deformable plastic material 2a, 2b and 2c. The platforms 4 are attached to a load distributing base 90, which itself comprises three sheets 3a, 3b and 3c. Therefore the racking pallet of Fig. 10 is preferably comprised of six sheets of molded plastic.

[0059] In Fig. 3 the first sheet 2a thermoformed in the triple sheet thermoforming sequence is the bottom member 10. The bottom member 10 includes a plurality of legs 12 that support the pallet's underlying deck 14 a

predetermined distance above the floor or pallet platform. The bottom member 10 also includes a perimeter margin 16 comprising sidewall regions 18 and corner regions 20. The perimeter margin 16 also includes borders 24, which borders define the terminating edge 26 of the bottom member 10. Within a deck region 28 extending between the legs 12 and the side wall and corner regions 18 and 20, are a plurality of molded in details 30 that extend upwards from a substantially flat base 32. Details 30 may also depend downward from the base 32. Portions 34 (suggested in broken line detail in Fig. 4) of the upper scuffed surfaces 36 of the details 30 and perimeter margin 16 of sheet 2a are developed to achieve interfacial contact and hot tack adhesion with the underside un-scuffed surfaces 42 of sheet 2b. Thus it may be appreciated that the bottom member 10 achieves interfacial contact with the center member 40 throughout several locations in a complex reinforcing manner to produce a twin sheet subassembly.

[0060] Now referring to Fig. 4, the center member 40 of a present embodiment is shown. The center member 40 is derived from sheet 2b and is the second member to be thermoformed in the triple sheet methodology. The top surface 38 of sheet 2b is scuffed according to the referred manner. Center member 40 comprises planer surface 44 with a plurality of upward extending details 46 supporting the top member 60, and a plurality of downward extending details 48 reinforcing the bottom member 10. Portions 50 (suggested in broken line detail in Fig. 5) of the underside 42 of surface 44 and portions of the downward extending details 48 of member 40 are developed to contact and bond

to the upper surfaces 34 of the bottom member 10. Accordingly, it may be appreciated that when the two members 10 and 40 are brought together under compression in the triple sheet method, interfacial hot tack adhesion occurs there between in a complex arrangement in a plurality of locations to provide a selectively fused together unitary twin sheet substructure.

[0061] As further suggested in reference to Fig. 4, the center member 40 comprises a number of other reinforcing details. These details include, but are not limited to leg elements 51, reinforcing steps 52, stiffening cross members 54, laterally arranged channels 56, projection posts 57 and perimeter boarder projections 58, which projections 58 are arranged to deflect side wall impacts from fork lift tines and the like.

[0062] Now referring to Fig. 5, the top member 60 of a present embodiment is offered. The top member 60 is derived from sheet 2c, and is the third member to be thermoformed according to the triple sheet method. The top member 60 comprises a substantially flat scuffed exterior surface 62 extending between the depending leg pockets 64 and the downward extending peripheral margin 66 defining an edge 68 of the top member 60. As may be appreciated by referring to broken lines 70, the top scuffed surfaces 38 of member 40 achieve interfacial contact with un-scuffed underside surfaces of member 60 when the two members are brought together under compression in the triple sheet method. According to this arrangement, a unitary pallet construction comprised of three selectively fused together sheets 2a, 2b and 2c of plastic results yielding a pallet

4a with a complex geometry of rigidifying elements providing break through load bearing strength.

[0063] The present embodiment represented in Figs. 3, 4 and 5 in combination produce an article referred to as nesting or nine-legged pallet 80 which is illustrated to advantage in Fig. 1. The present embodiment illustrates to advantage the ability of the triple sheet method to mold a more complex structure engineered to support relatively more load bearing weight than a comparable twin sheet structure of an equivalent amount of relatively expensive plastic material. The center member 40 provides a honeycomb type structure imparting significant increases in load bearing strength. Reducing the amount of plastic used to make the triple sheet structure is therefor suggested to gain efficiency and competitive advantage within a market now dominated by less expensive wooden pallets. In the preferred improved methods, sheets of plastic are scuffed in accordance with the described method to increase hot tack adhesion under compression in order to optimize the use of thinner gauge sheet for the lowest material weight structure.

[0064] It may also be appreciated that the improved strength associated with the pallet 80 embodiment represented in Fig. 1 may be applied to other pallet embodiments, including that shown in Fig. 2 which is a nine legged pallet platform 4b. By way of further example, the load distributor 90 of Fig. 6 which is portrayed in the combination of Figs. 7, 8 and 9, is also constructed of sheet scuffed for improved bond strength.

[0065] In the present sequence of the triple sheet methodology used to thermoform load distributor 90, the first sheet 3a of Fig. 7 is deformed against a first mold positioned upon the lower platen. The top surface 94 of sheet 3a is un-scuffed, while the underside surface 96 is scuffed. The underside surface 96 includes a plurality of locations 98 where the first sheet 3a achieves hot tack adhesion with corresponding locations 100 of sheet 3b when these are brought together under compression.

[0066] Sheet 3b is the center member 102 of load distributor 90. Center member 102 has a scuffed undersurface 106 and an un-scuffed upper surface 104. Surfaces 96 and 104 are developed to fuse in pre-selected locations 98, which are suggested for illustration by broken lines 108 seen in Fig. 7. The scuffed under surface 106 of the center member 102 is developed to fuse to the un-scuffed surface 122 of sheet 3c forming the base member 120 of load distributor 90.

[0067] Accordingly, it may be appreciated that after sheet 3c is deformed over a third mold, the scuffed surface 106 of sheet 3b is fused to sheet 3a, which remains in communication with the first mold. The first mold is sequentially compressed against the third mold, so that the un-scuffed surface 122 of the base member 120 achieves hot tack adhesion with the scuffed surface 106 of the center member 102. This arrangement provides a unitary triple sheet structure known as a load distributor 90, with a scuffed underside surface 124 having a relatively high co-efficient of friction. The skid resistant bottom surface

124 of load distributor 90 is preferred so that load distributor 90 will not unnecessarily move or dislodge during its intended use.

[0068] Accordingly, the present embodiment of a load distributor 90 can be constructed out of three sheets of plastic that in combination weigh less than the combination of twin sheets used to produce a comparable load distributor with the same load distributing strength. A comparable twin sheet load distributor may be known by referring to United States Patents 5,638,760 and 5,758,855, both to Jordan et al. In the present preferred embodiment, three relatively thinner sheets are scuffed to encourage increased hot tack adhesion and a more robust pallet construction.

[0069] Referring now in detail to Fig. 10, it is suggested that load supporting platform 4b and load distributing base 90 can be combined to provide a rackable pallet 150b. As can be seen, pockets 152 associated with the distributor 90 receive legs 12 of platform 4b. As is also suggested, either of the platforms 4a or 4b and distributor 90 can be advantageously combined to provide a unitary pallet in the manner suggested by illustration.

[0070] In present embodiments, which may best be understood by now referring to Fig. 12, rigid legs 12 are constructed out of sheets 2a, 2b, and 2c. In the proximate location of the leg bottom 154, the sheets 2a, 2b and 2c come together under compression to provide a location for a leg drain hole 156. In the location of leg bottom 154 of pallet 150a, the sheet 2a is developed to engage sheet 3a, which is developed to engage sheet 2a. Sheet 2a comprises opposed vertical walls 160 and flat surface 162 in the leg bottom 154. Along walls 160 are

projections 164, which result from (mechanical) tooling developed to thermoform undercut details. Sheet 3a comprises vertical walls 166 and flat surfaces 168 within a recess 170 formed by a pocket 152 receiving the leg 12 of sheet 2a. Along vertical walls 166 are recesses 170, which result from (mechanical) tooling developed to thermoform undercut details. The recesses 170 receive the projections 164, when a platform 4 and distributor 90 are compressed together in an overlaying relationship. Although the preferred arrangement is a triple sheet construction for the advantage of strength, the formation of projections and recessions can be adapted for twin sheet thermoforming purposes. As also is preferred, sheets 2b and 3b are developed to reinforce the regions 172 around the projections 164 and recesses 170.

[0071] As seen in Fig. 13, projections 164 may be adapted to receive cross members 172, such as for example a wooden 2 x 4, or the corresponding triple sheet pallet member recesses 165 as suggested, depending upon the preferred use of platform 4.

[0072] A further explanation of the formation of the projections and recessions in the respective members is suggested in Figs 14 and 15. In Fig. 14, the application surface 130 of first mold 132 receives a machined cut 134. The machined cut is adapted to receive mechanical “under cut” thermoforming apparatus 136. The apparatus is for the projections 164 and includes actuated elements 166 responding to process control instructions of the thermoforming machine programmable logic controller. In Fig. 15, the corresponding apparatus for thermoforming the recess is suggested.

[0073] The advantage of utilizing common mechanical apparatus for each projection and recess interface is that the mechanical apparatus can be duplicated for all thermoforming molds in the product line category. Accordingly, bottom members 10 may be used for both nine leg platform 4b and inter-nesting platform 4a applications and in association with a smaller number of load distributors 90 for racking and other unit load platforms 150. The pool of members 4a and 4b and 90 can be selectively reconfigured using the snap-fit feature to meet variable demand throughout the distribution system.

[0074] Referring now to the nationwide distribution system associated with the use of a standard 40 inch by 48 inch wooden stringer pallet, it has been determined by associations of wooden pallet end users that approximately 30% of all unit loads are less than 1000 pounds, and that 66% weight less than 2000 pounds. The remaining unit loads, representing approximately 14%, weight today's 2800-pound wooden pallet specification. Accordingly, it is suggested that the triple sheet members presently embodied in Figs. 1, 2 and 6 interface in combinations of construction that are adapted meet the three unit load threshold requirements of industry with at least the three platform configurations represented in Figs. 1, 2 and 10.

[0075] Accordingly, the platform 4 is offered in three styles 4a, 4b and 4c. The first style of member 4a is suggested in Fig. 1 and includes a load-supporting surface interrupted by a plurality of leg pockets for consolidated storage and shipping. The second style is member 4b of Fig. 2, and is provided with an uninterrupted surface. The third style 4c is a derivative of style 4b and

includes reinforcing elements 180 for additional load supporting strength. The style 4c is not shown.

[0076] Furthermore, the distributor 90 is offered in two styles. The first style 90a is illustrated in Figs. 7, 8 and 9. The second style 90b includes the addition of reinforcing members 180. The second style 90b is the 90a style without the reinforcement members. (Both styles are suggested in Fig. 8.)

[0077] The three models suggested above can produce a product line of 9 part numbers or combinations. Several combinations are suggested for a range of pallet criteria described above. Accordingly, the interoperability of members 4a, 4b, 4c, 90a and 90b is a desirable characteristic from the standpoint of resource allocation and asset management practices. It is also preferred that the inventions and improvements suggested by the present applicant's US patent application Serial No. 60/177,383, entitled "Thermoformed plastic pallet with RF devices", be adapted to the present inventions where desirable to improve the over-all efficiency of the present pallet members within the North American distribution system.

[0078] Referring back to Figs. 7 and 8, reinforcing members 180 are suggested. In particular, it can be seen that elements 182 of sheet 3a extend downward to engage the reinforcing members 180, and elements 184 of sheet 3b extend upward to engage the reinforcing members 180. Elements 186 of sheet 3c may also extend upward to reinforce the elements 184 of sheet 3b engaging the reinforcing members 180. The arrangement produces a stiffer member 90b than the non-reinforced member 90a. The member 90a formed

without the reinforcing elements 180 is nonetheless stronger than an equivalent twin sheet plastic member utilizing the same measure of plastic is as the triple sheet member 90a. When the reinforcing elements 180 are excluded from the construction, the elements 182, 184 and 186 otherwise engaging said members 180 are encouraged to selectively web 188 in preferred locations, to deform for strength advantage in areas 190, or to fuse to corresponding surfaces 192 of an associated sheet 3 a, b or c.

[0079] It may be appreciated that the present objective of utilizing one mold group to produce successively more rigid triple sheet members may be applied to a range of suitably developed load bearing platforms. Accordingly, reinforcing members 180 may be inserted within the structure of a load-supporting platform 4c as well as a load-distributing base 90. (It should be noted that the embodiment represented in Figs 3, 4 and 5 do not contemplate the dual modes of construction contemplated in the single set of molds associated with Figs 7, 8 and 9, because the disclosure of Figs. 3, 4 and 5 proposes a nesting nine legged pallet in which case the pockets would interfere with elongated members 180.) Furthermore, depending upon the preference of the practitioner, it may be desirable to develop the members forming the triple sheet structures to receive reinforcing elements between the first and second sheet, or / and between the second and third sheets of the triple sheet construction.

[0080] Referring again to the distribution system, it is known that the pallets within warehouse environments from time to time become involved in fires. The present plastic pallet embodiments may therefore be adapted in the

preferred manner described below to provide a level of protection against fire that is equal to or greater than wooden pallets. Normally, polyolefins such as polyethylene and polypropylene upon exposure to a combustion flame quickly melt and ignite to sustain combustion and to drip a burning liquid spreading the flame. In the present embodiments of thermoformed pallets in which case three sheets are used, the two outer sheets alone are provided with intumescent properties, which properties are imparted upon the outer exposed surfaces of the sheets by means of a co-extrusion process. When exposed to flames the intumescent additives in the co-extruded cap stock 300 react or decompose to convert the cap stock into a residual insulating foam-like structure that is resistant to burning. In this manner an intumescent sheet construction prevents the polyolefin from rapidly melting and dripping burning liquids. The intumescent polyolefin composition 302 that is preferred and can be used for the present application is in accordance with United States Patent 5,834,535 to Abu-Isa et al. which issued November 10, 1998 and is incorporated herein in its entirety by such reference. Among the advantages of the cited intumescent polyolefin composition is that this material is particularly suitable for thermoforming applications and is amenable to deep draw ratios of 400 percent, which is a critical aspect for forming the leg pockets of the nine-legged pallets of the present embodiments.

[0081] In addition to providing the advantage of a comparably low cost pallet construction, in which only the exposed surfaces 304 of a pallet is composed of said intumescent compositions, the arrangement provides another

benefit that is particular to triple sheet pallet members. Polyolefins 306 have a comparably low temperature softening point and when this threshold is reached the polyolefin structure quickly softens and loses its structural strengths. Therefore, even though a twin sheet pallet provided with an intumescent barrier in accordance with the cited reference may resist dripping flaming liquids, the backside of the sheet may still be subjected to high temperature which may cause the molded structure to soften and collapse. In this event, articles stored upon the collapsing pallet will spill off the pallet, which could create additional damage or injury to workers. According to this problem, the two exterior surfaces of the plastic sheets forming the present pallet embodiments of 4 and 90 are provided with intumescent properties in accordance with cited reference because the cited reference is known to have comparably superior thermal insulating properties. Therefore, the intumescent efficiency of the surfaces of the pallet will provide a thermal insulation that in cooperation with the hollow areas of air space 308 within the triple sheet pallet construction will help preserve the integrity of the interior structural member 310 of the pallet. In this manner, the triple sheet pallet will be better able to support its load under high heat, which would decrease property damage and limit potential worker injury. The present arrangement of a triple sheet pallet constructed out of three sheets, wherein the exposed surfaces 304 of the outer sheets have intumescent cap stocks 300, is disclosed in Fig. 11. It may also be appreciated that inside structural sheet 310 may be composed of polyolefins having agents and fillers that sustain the stiffness of the plastic structure in elevated temperature conditions.

[0082] The intumescent cap stock 300 of the sheets forming the triple sheet article may also be scuffed according to the principles described above for either the purpose of providing improved hot tack adhesion and bond strength or for providing a surface with a high coefficient of friction for skid resistance.

[0083] Plastic pallets having communication capabilities have also been proposed. These communications capabilities can be adapted to respond to fire or the high heat of combustion flames. In one such embodiment, as suggested in Fig. 3, a pallet contains an internal wireless communications device 400, such as a simple wireless cellular receiver transmitter. The device 400 interfaces with a thermographic instrument comprising circuitry 402 connected to a thermoscopic probe 404 exteriorly positioned upon an exposed surface 406 of the platform, as in Fig. 2. When the thermographic circuitry 402 records a variation in temperature indicative of a fire through the probe 404 the device 400 is triggered to transmit an emergency 911 signal to a remote monitoring responding station. As suggested in the inventor's co-pending application referenced above, the signal transmission may include data packets specifying location, time, heat, load sustained, customer, packing list, manifest, maintenance, and intumescent pallet performance specifications. In even more sophisticated environments (laboratory, outer space or underwater), when performance specifications are known by two-way communication to be nearly exceeded, the device 400 may receive a final emergency signal to activate instrumentation causing stored media (two part composition media stored within two compartments formed by triple sheet pallet) within the internal cavities of the

platform to react to produce temperature lowering, flame diffusing consequences and co-communicating personnel evacuation protocols. It would normally be appreciated the device 400 and thermographic instrumentation 402 may be powered by first and second supplies, the second power supply such as a solar battery 408 being exteriorly exposed, as for example, upon a detachable plate 410 adjacent the thermoscopic probe 404. The same solar battery power supply may also be developed to power a RF transponder associated with the remote probe 404 to the transmitting receiving device 400 protectively located within the interior of the thermoformed article. Although wireless communication from probe 404 to device 400 is suggested, the arrangement can be substituted with a hard line circuit placed inside the pallet during the thermoforming process.

[0084] Referring back to Figs. 1 and 10, it may also be observed that the pallets embodied in the present drawings include ergonomic features that are present to assist the warehouse worker manually handle a pallet. In Fig. 1 a pair of handles 320 are provided to allow the worker to manipulate the nesting pallet 80. It may also be appreciated that when the pallet 80 is manipulated it will be dragged upon the floor at the legs 12 at the opposite end thereof. In order to prevent the legs 12 from thinning due to long-term abrasion skid plates 322 are offered. In the alternate embodiment represented in Fig. 10, handle structures 320a and 320b are also shown. Opposite said handles upon the load distributing platform 90 is a skid plate strip 324 that is provided to provide resiliency to pallet 10. It may also be suggested that the handles 320 may take other forms, and may for example be retractable from the side wall 16 position, or may involve a

hand size cut out adjacent a pallet margin where the sheets forming the pallet are compressed together to form such sections amenable for said hand cut outs. It may also be advantageous to provide handles and plate along a plurality of pallet margins for ease of use.

[0085] Referring again to the distribution system, it is the case that goods supported upon a pallet are unitized into single loads. The unit loads are often times provided with a wrapping to protect and seal or a banding to contain the associated cargo. In the case of wrapping a unit load, the preferred industry method is to unfurl a stretch film around the unit load. In order to initiate this mode of wrapping, the film must be secured in some manner so that the film can be stressed around an adjacent corner to desired effect. The present embodiment suggested in Figs 2 and 10, and further suggested in Fig 17, includes pockets 200 which depend downward about the corner regions 20. Two pocket styles are shown. A first style of pocket 200a is associated with corner region of sheets 2a and 2b. In the present example, a web 204 is formed between side-by-side corner pockets 202. The web 204 is opened up in secondary operation, such as by routing. The film is knotted and wedged within the opening 206 of the web. The knotted film end is held in place by the associated opening 206 when the roll of shrink-wrap film is unfurled around the unit load. (The opening in the web is added when the legs receive the drain holes.) In another embodiment the plastic deforms over the side-by-side corner pockets, and no webbing occurs, as in Fig. 2. The end of the film is knotted and twisted around the pockets in an ∞ (eight) motion, which secures the film so that

it may be unfurled around the adjacent corners of the unit load. The isolated pockets 208 suggested along the region 18 between the legs are contemplated as a serrated border that is operable to engage the stretch wrap film as it is deployed for the desired purpose. The pockets 200 and 208 along the margin of pallet may also be adapted to retain banding in a desired location about the unit load. Similarly, the pockets may be developed to restrain the ends of tensionable straps used to unitize a load. As seen in Fig. 10, the corner pockets 200 may also be added as secondary pieces 210 after the pallet has been thermoformed. With this arrangement the pieces 210 could be replaced from time to time as these wear after repeated use or as a result of abuse in the pallet environment. The skid plates 322 and 324 may also be replaced at the same time as part of a pallet maintenance regimen.

[0086] In summary of the above, the present objects of the invention are achieved, and several other improvements are suggested. It is to be understood that the drawings and descriptive matter herein are in all cases to be interpreted as merely illustrative of the principles, methods and apparatus of the invention, rather than as limiting in any way, since it is contemplated that various changes may be made in various elements to achieve like results without departing from the spirit of the invention or the scope of the appended claims.

[0087] The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.